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ABSTRACT

Since previous communications technologies have led to the development of new literary genres, it is reasonable to assume that computer-based communications media will also adopt a unique way of structuring information. The forerunner of this new literary form may well be the Delphi Technique which has been developed as a forecasting methodology. The information units in this form consist of short descriptive statements accompanied by background information and a probability measure; they are flexible, openended, and user-controlled. Data from early versions of an "exploration of the future" on the PLATO system at the University of Illinois show that they have potentially significant implications, particularly in areas such as public debate and political and social decision-making. (Author/PB)

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STRUCTURING INFORMATION FOR A COMPUTER-BASED COMMUNICATIONS MEDIUM

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This paper was prepared for the Fall Joint Computer Conference of the American Federation of Information Processing Societies (AFIPS) held in Las Vegas, Nevada, on November 15, 16, 17 and 18, 1971, and is published in the proceedings of that conference.

ABSTRACT

Hardware now being developed for use in computer-based education can be thought of as the forerunner of a new generation of communications media. Since previous communications technologies have led to the development of new literary forms, it is reasonable to assume that computer-based communications media will also adopt a unique way of structuring information. The forerunner of this new literary form may well be the Delphi Technique which has been developed as a forecasting methodology. This paper outlines the use of "information units" as a flexible way of describing possible futures, presents data from early versions of an "exploration of the future" on the PLATO system at the University of Illinois, and discusses how this data might be thought of as examples of feedback messages in the two-way literary form of a computer-based communications medium.

Several years ago Prof. Charles E. Osgood suggested that it might be possible to develop a program for a computer-based education system which would eventually allow the public, possibly at a world's fair, to "explore the future."[1] Such an "exploration" would be useful both for education and for social science research. This paper is the fourth in a series of progress reports on the continuing development of that "exploration of alternative futures" using the PLATO system (see Figure 1).

The educational function of the exploration is accomplished by exposing the "explorer" to four types of information:

1. A list of developments possible in the future.
2. The model of "reality interaction" used in the computer program.
3. The decision-making procedure, including making investments to change probabilities.
4. The operation of a teaching computer.

With regard to research the responses of explorers provide useful social science data. The data from these exercises can reveal which developments people consider desirable, which developments they are most familiar with, and which developments they are most interested in. Data from several demonstrations of early versions of the exploration will be discussed later in this paper.

In short this work originated neither as an attempt to develop software for a new communications medium nor from an interest in conducting on-line Delphi studies as a decision-making aid. The

Figure 1. The PLATO III system provides each student with an electronic keyset as a means of communicating with the computer and a television display for viewing information selected or generated by the computer.

direction in which the research moved resulted in part from the nature of the medium and in part from our concern with increasing public participation in decision-making processes.

THE EVOLUTION OF THE PROJECT

After the project had been underway for a year or two, it appeared that this work could have applications beyond simply education and social science research. This belief resulted from the projected growth of the PLATO system and the ease with which the computer program for the exploration could be modified to deal with problems other than the general future of mankind.

A glance at the past

The PLATO III system, which we have been using, is capable of operating 20 terminals simultaneously. However, the PLATO IV system, scheduled for completion in 1974 or 1975, is being designed to operate 4000 terminals simultaneously (see Figure 2).

When the first wave of interest in computer-aided instruction began in the early 1960's there were basically two questions which had to be answered. First, could students learn educational material as rapidly and retain it as well if they were taught using a computer terminal rather than by sitting in a classroom? Second, was computer-aided instruction economically competitive with classroom instruction? After a decade of educational experiments at the University of Illinois and elsewhere, the answer to the first question is emphatically yes.[2] But computer-aided instruction is not economically competitive using the technology available in 1960. It was this realization - that the crucial problem lay in the cost of the equipment and its operation - that led to the invention at the University of Illinois of the plasma display panel and the development of the PLATO IV system.[3]

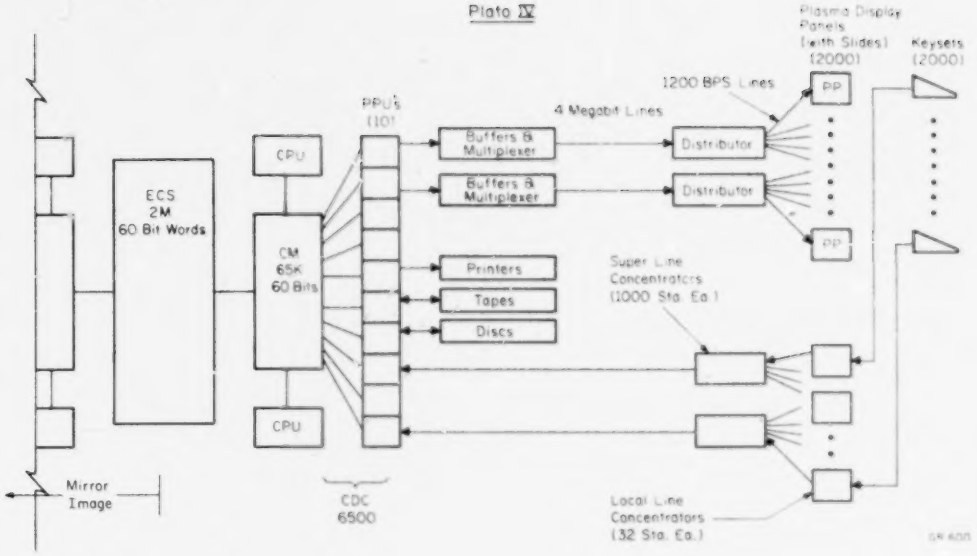

Figure 2. Using terminals such as the one pictured above, the PLATO IV system scheduled for completion in 1974, will provide a high quality color display at low cost. The terminals will be connected to the computer over standard voice-grade telephone lines.

A computer-based education system which is both educationally effective and economically competitive will in all probability be adopted throughout the United States and around the world in due course. With the prospect of teaching computer terminals in most classrooms, if not most homes, within a few decades, we began to think of this equipment as a new kind of mass communications medium.

Generations of communications media

If radio and television are thought of as first and second generation mass communications systems, then perhaps the PLATO system could be thought of as a forerunner of a third generation mass communications system. Originally, we felt that built-in feedback would be the characteristic distinguishing computer-based communications systems from radio and television.

However, due to the feedback possibilities of cable television, it now seems more appropriate to list four "generations" of electronic communications media now existing in at least prototype form.

1. Radio transmits audio messages from the center to the periphery.
2. Television transmits audio and visual messages from the center to the periphery.
3. Cable television provides a great increase in the number of available channels and the possibility of both passive feedback (monitoring what people watch) and active feedback (for example, voting by pressing a button on the television set).
4. Computer-based communications systems have several new characteristics.
   a. Less simultaneity: Although many people may be using the same program, each may be in a different part of the program. Thus everyone on one "channel" does not see the same thing at the same time.
   b. Less evanescence: With radio and television a listener

or viewer cannot go back if he misses a word or sentence (unless he has a tape recorder). With PLATO each individual progresses at his own rate. The display does not change until he wants it to, and he can go back to review previous displays.

c. Viewer-designed programs: With PLATO the viewer can ask for additional information or can jump ahead if he becomes bored, thus to some extent designing his own program.

For the sake of clarity it should be noted that the displays for computer-based communications systems are generally static, like color slides, rather than dynamic, like movies or television. Messages are conveyed primarily by the use of words, frequently supplemented by tables or graphs and occasionally by drawings and pictures. However, the PLATO IV equipment, as contrasted with the PLATO III equipment, will use audio as well as visual messages and will be better suited to simple moving displays such as dancing stick figures or plotting out a graph.

Applying the exploration to specific issues

Even before we began thinking of the PLATO system as a new kind of mass communications medium and not simply as a teaching device, we had thought of writing explorations on a variety of different topics such as disarmament, the future of education, and urban planning. But with the probable widespread acceptance of computer-based education in the next few decades, it seemed that our work suggested the possibility of using this equipment as a medium between planners and the public for exchanging information and opinions regarding community goals.[4]

The adaptability of the exploration resulted from the fact that the decision-making framework could remain the same for any problem area and that only the information units with the matrix giving the

relationships between them would need to be changed.

Thus the projected expansion of the PLATO system and the ease with which the exploration could be modified to deal with specific issues resulted in our thinking of the teaching computer as a new kind of mass communications medium particularly suited to discussions among different interest groups about the long range goals of a community. But how does one present information on this new medium?

HOW DOES ONE DESCRIBE THE FUTURE?

Programming an exploration of the future required suggesting possible future developments in a way which emphasized their probabilistic nature and in a way which could be easily manipulated by the explorer. We needed a method of presenting possible future developments so that people could request additional information, make "investments" which would alter the initial probabilities, and see the possible secondary effects of their actions. Consequently we assumed that the future, and also the present and the past, can be described using "information units".

Features of information units

The features or components of an "information unit", as described in an earlier report, were 1) a short descriptive statement, 2) a background paragraph, and 3) an associated probability or other measure.[5] It now seems necessary to expand and revise this list of features.

The background information (2) can involve graphs, charts, pictures, drawings, and tape recordings in addition to written information.

Complete measurement (3) of an historical occurrence requires the measurement itself, the date the measurement was made, and some

indication of measurement error. The measurement of a forecast requires the forecasted value of a parameter, the date at which that value of the parameter is expected to occur, some indication of certainty about the forecast, and also the date at which the forecast is made.

With respect to graphs of information units, the horizontal axis will always be time. The vertical axis which we have used so far for developments has been probability, ranging from 0 to 100 percent. This kind of scale requires a specific, identifiable event such as 50 percent of the nation's schools having computer-based education equipment or 50% of the population favoring the legalization of marihuana. A superior method of forecasting would lend itself more easily to validation and would make possible the measurement of progress toward a goal as the years pass by. Such a scale is suggested by the previous format. Rather than measuring the probability of a particular level of distribution of a technology, one can simply measure the distribution itself. Similarly one can estimate the percentage of the population which will favor a social development rather than the probability of a particular degree of acceptance. Regarding the development of a technological capability, as opposed to its diffusion once it is developed, one could list the stages of development ranging from the original concept through experimentation and prototype construction to the first production model. However, this kind of measure would use an ordinal rather than an interval scale.

An important new feature which should be noted explicitly when developing lists of information units is the group or person suggesting a particular idea as important (4) and worthy of attention. This information can usually be deduced either from the name and affiliation of the person writing the paper or from the list of people who took part in a Delphi exercise. The person or group originating an idea

is frequently recorded. However, the thought behind recording this data is usually either to aid in locating additional background material or to give credit where it is due. But such information is also politically relevant. It is needed so that other forecasters, public officials, and especially the general public, will know whose ideas about the future of society are represented in the total set of forecasts and social indicators now being generated. People in different walks of life, in different socioeconomic groups, will be subjected to different stresses in their daily lives. Consequently they will define different "problems" as being important for mankind to solve. The intervention of politics into forecasting cannot be avoided, we can only try to be aware of possible sources of bias so that the interests of all groups will be as fairly represented as possible.[6]

Categories of information units

Information units can be divided into four categories:

1. Developments, including both social and technological developments, refer to new characteristics of the social system.
2. Initiatives are actions taken by a group or an individual.
3. Events are sudden or unanticipated occurrences.
4. System variables, now more commonly called social indicators, are measures of a system which fluctuate in time.

Two criteria are used to distinguish among these four kinds of information units: the shape of the graph over time and the extent of human control.

Type of information unit	Shape of graph	Human control
Development	S-curve	Many small decisions
Initiative	Step function	Single large decision
Event	Spike function	Very little control
Social indicator	Fluctuation	Regular adjustments

The earlier report suggested that the four categories of information units could be thought of either as "change-producing factors" (developments, events, and initiatives) or as "system variables" (social indicators). The distinction between these two larger categories lies in the period of time during which the information unit can usefully be of interest. System variables or social indicators are of interest over an indefinite period of time and so are used to monitor the behavior of social systems. Change-producing factors can occur in a period of hours or years but are of little interest outside of the period of time during which they are producing change in the social system.

Most mathematical models deal with the relationships among several "system variables", such as population, per capita income, gross national product, and capital investment in agriculture. Delphi studies usually concern themselves only with "change producing factors". An ideal exploration of the future would use both system variables and change-producing factors.

A new literary form

Every new communications medium seems to generate its own distinctive forms for structuring information. The printing press made possible newspapers, journals, and novels. Films greatly extended the use of animated cartoons and led to zoom and pan shots, parallel editing and special visual effects. Radio and television produced the talk show, 15 minute news, commercials, and spot

announcements. The mimeograph machine was best suited to the leaflet, the working paper, and the "underground press". The xerox machine promoted letter writing to multiple recipients and extended the readership of journal and magazine articles. It is not surprising that computer-based communications media also seem to be developing their own literary form.

Branching sequences and mathematical algorithms, so useful in "individualized instruction", create a demand for literature in which statements and paragraphs can be rearranged, dropped or added. Scripts or programs which follow the single logical sequence of the essay are criticized by the managers of the medium as "not taking full advantage of the capabilities of this kind of system". In such cases there is pressure to either rewrite the material or present it using a different communications medium.

Rather than an articulate text with an interest-arousing introduction and a good summarizing conclusion, the material written for a computer-based communications medium, particularly when it deals with public issues, emphasizes alternatives and their consequences and concisely stated, measurable events. With this medium a person can describe his ideal future without having to give a speech or write an essay or book. Furthermore, his views can be easily compared or combined with the "ideal futures" of other people, thereby informing the explorer, the programmer, and the general public what visions are dancing in the heads of their fellow citizens.

We have long needed a literary style which, rather than imposing a particular idea, tends to draw out new ideas, and which tends simply by its form to make normally implicit assumptions explicit so that they can be challenged. When people see that they disagree about the relationships between developments or events they may discover that their disagreements are not about basic values or

goals as much as they are about factual questions such as what does in fact lead to what.

The future-oriented literary form of the Delphi Method is different in several important respects from the present and past-oriented literary forms more commonly used today.[7] The essay form, whether a newspaper report, a magazine article or a book, is most useful for developing a single idea to a certain degree of detail. A story related in this way has only one plot and all the subplots are related in the same way for all readers. Thus for the reader it is not a very personalized artistic form, no matter how weird one's powers of interpretation. It is little wonder that one criterion of quality in a short story or novel has been the range of interpretations or meanings which can be drawn out of it. This practice might be thought of as bestowing cuddos for the ability to transcend the limitations of the medium. Imagine the artistry possible if a literary form could be designed which had nearly all of the strong points of the essay but reduced or eliminated some of the limitations!

The essay requires only the passive involvement of the reader. Fantasy and relationships with previous knowledge or experience can be brought into play, but the new ideas which are generated cannot be tested out in the story itself. Literary essays, reports, stories, even films, plays, and melodramas are closed ended and are characterized by high certainty. Events do or do not happen. The closest thing to the hypothetical or probabilistic is the scientific report with its margins of error and the assumption that refutation is possible. But the scientific report states facts, not possibilities. Even science fiction stories while beginning from a hypothetical situation follow a fixed course to a unique conclusion.

Robert Theobald's Teg's 1994 a mimeographed, alterable account of a small girl's possible future world is one example of rumblings of a demand for new literary forms which are flexible, probabilistic,

open-ended and user-controlled, thereby permitting active involvement of the reader.[8] A more conditional and manipulable style of literature will not be very satisfying and may be downright disconcerting to some people. It will probably be most satisfying for people who have a high tolerance for uncertainty and ambiguity and who appreciate being asked for their judgments as well as being given someone elses. A plot not subject to influence other than interpretation is suitable for a past not subject to influence other than interpretation. A future susceptible to action and open to invention requires a medium which invites action and encourages invention.

THE EXPLORATION AND SOME RESULTS

With the preceding background on how our thinking about the project has evolved and the refinement of what is meant by information units, we shall now pause in our speculations for a look at the present version of the exploration and the data which has been collected so far.

An outline of the exploration

The decision-making procedures in one cycle of the 40 information unit exploration were as follows:

1. From a list of the 35 social and technological developments programmed into the computer the explorer chooses a development whose probability he would like to change.[9] The object is to make more probable those developments which the explorer considers desirable and less probable those developments which the explorer considers undesirable. However, desirable developments may have undesirable secondary effects, and undesirable developments may have some desirable secondary effects.

2. The explorer makes an "investment" (an indication of desirability) between -100 and +100, where -100 would mean that the development is maximally undesirable, 0 would mean that the development

is neither desirable nor undesirable, and +100 would mean that the development is maximally desirable. An investment such as +50 would mean that the development is moderately desirable. In the present version, no limit is placed on the total amount which can be invested in an exploration. 100 units could be invested during each cycle.

3. The computer shows in table form the secondary effects of the explorer's immediately preceding investment according to the estimates of secondary effects put into the computer by the programmer. For each development listed as a secondary effect the computer displays the old probability (before the investment) and the new probability (after the investment) and the change in probability (the difference between the two).*

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* For a discussion of the mathematical model used in the exploration and the decisions which have to be made by the programmer, see reference 5.

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4. An oracle message is displayed. Oracle is a verbal message telling which developments are likely to happen in the year 2000 and which are not likely to happen, on the basis of the current probability of each development in the exploration.

5. At the end of each cycle the computer performs several random calculations to determine whether an "event" occurs. If an event does occur, a background paragraph about it is presented and then its effects on the probabilities of the social and technological developments are shown by a table of secondary effects.

Tradeoffs due to hardware and software limitations

The primary limitation on the complexity of these explorations has been the amount of computer memory allocated to what is called student bank, the number of words accessed by only one terminal.

The number of variables can be increased somewhat by packing, but of course this procedure involves a limit as well.

The 15 information unit explorations, particularly the later ones, involved a larger number of decision-making operations in each cycle, such as indirect investment (what other developments are likely to affect the occurrence of the development under consideration) and asking for estimates by the explorer of some of the probable secondary effects of the development being considered.

When the number of information units was expanded to 40, the number of decision-making operations performed by an explorer in each cycle was decreased. This reduction resulted both from the demand for more variables caused by more information units and from the addition of some more sophisticated computer operations.

Discussion of the data

Since work on developing the computer program began in the fall of 1966, sixteen demonstrations of an exploration of the future have been given during which data was recorded. Numerous demonstrations were given during which data was not collected. Table I lists by dates the demonstrations during which data was collected. The number of people participating in the demonstration and the background of the group are given in the second and third column. The right hand column contains notes about the nature of the program, such as the number and categories of information units and the decision-making operations which were added or dropped since the previous demonstration.

The first 11 demonstrations were of an exploration having only 15 information units, all of which were either social or technological developments. Demonstrations 12-16 were of an exploration having 40 information units--35 social and technological developments and 5 events. Table II lists the 35 social and technological developments

TABLE I

DEMONSTRATIONS WITH RECORDED DATA

	Date	Number of people	Group	Notes
1.	3/9/68	?	?	1. 15 information units 2. uses GENERAL language 3. only comment data
2.	3/13/68	?	?	(Always same as preceding demonstration except as noted)
3.	5/12/68	17	Social Science Undergraduates	1. uses TUTOR language 2. no comment mode 3. primary development (PD) selected randomly and not recorded in data 4. shows background paragraph for PD 5. investment is only +, 0, - 6. asks for relationship of PD to 4 predetermined secondary developments, relationship must be given as +,0,- 7. select 5 to follow, option to see 3 other secondary effects 8. 4 stage oracle 9. main calculation sequence is part of special version of TUTOR 10. secondary effects matrix read in by paper tape (+, 0, -)
4.	7/10/68	10	Social Science Faculty & Graduate Students	1. magnitude on investment can go to $\pm$ 99 2. asks for numbers of 3 developments which might affect PD and how they will affect PD (+, -)
5.	10/9/68	11	Undergraduates from several disciplines	1. indirect investment possible in up to 5 developments 2. no question on what developments affect PD 3. magnitude of investment can go to total of 100 in one cycle
6.	2/1/69	6	local press	
7.	2/17/69	7	Undergraduates from several disciplines	
8.	3/3/69	15	Political Science Graduate Students	1. Built-in comment mode
9.	3/4/69	9	Social Science Undergraduates	
10.	3/17/69	7	Political Science Graduate Students	

TABLE I (Contd.)

	Date	Number of people	Group	Notes
11.	5/12/69	13	Education Professors	1. data printout at end of each cycle, gives PD, cycle number, and probabilities for all 15 developments 2. calculation sequence and secondary effects matrix built into Delphi program
12.	2/14/71	9	Landscape Architecture Graduate Students	1. 40 information units, 35 developments and 5 events 2. PD selected by explorer 3. background paragraph for PD not automatically displayed, must be requested 4. no indirect investment 5. does not ask for estimates of 4 secondary effects relationships 6. automatic selection of secondary effects, only those whose probabilities are changed by the investment in PD 7. secondary effects matrix with relationships up to $\pm$ 3
13.	2/20/71	5	WBBM reporter and friends	
14.	2/27/71	8	Urban planning Graduate Students	
15.	2/28/71	13	Graduate Students in secondary education	
16.	3/6/71	6	Graduate students in religion	

according to the mean investment in each development.

Table III lists the developments in order according to the number of times each development was chosen as an object of investment. The greater the number of people who choose to invest in a development, the less influence each person has in determining its mean investment.

The number of times that background information was requested for each development is shown in Table IV. There are no doubt a variety of reasons for requesting background information. The more prominent items in the list seem to be those with which people are least familiar. Background paragraphs are also frequently requested on subjects which the explorer is familiar with, probably in order to test the expertise of the people writing the program. Similarly, controversial subjects seem to be called up in order to divine the political opinions of the programmer.

Ten minutes before the end of the hour each person is asked to type a code word in order to jump to a series of questions at the end of the exploration. Seven of these questions are listed in Table V. Question 2 asks, "If you had it to do all over again, would you change any of your investments?" If the explorer answers, "yes", he is then asked to list the numbers of the developments in which he would make a different investment. Table VI lists the 35 developments in order from the most to the least frequently mentioned in responses to this question.

Not all of the people who worked through at least part of the exploration completed the questionnaire at the end of the exploration. Fifty-four people participated in 6 demonstrations. Of that 54, 39 completed the questionnaire.

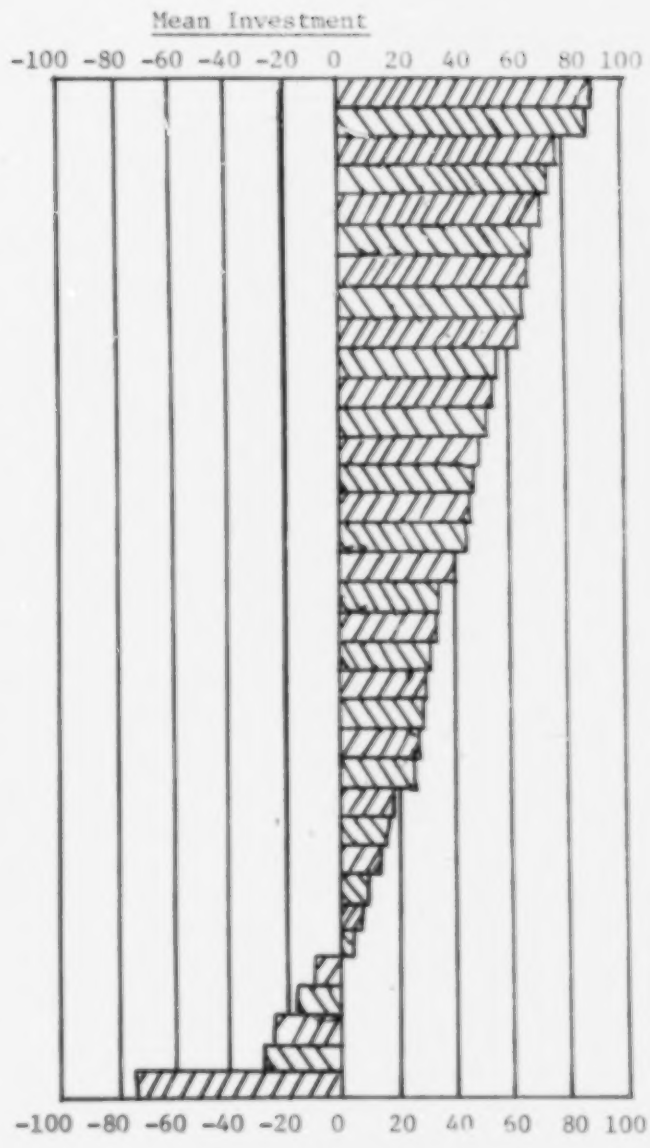
A non-random sample of people

It should be stressed that the people who took part in these

TABLE II

RANK ORDER OF DEVELOPMENTS
BY MEAN INVESTMENT*

	Development
1.	Pollution Control
2.	Racial Barriers Eliminated
3.	Abortion Legalized
4.	Population Planning
5.	World University
6.	World Currency
7.	Treaty Banning CBW R & D
8.	Complete Nuclear Disarmament
9.	World Aid Program
10.	Ocean Farming
11.	Synthetic Food
12.	Staggered Work Week
13.	Group Marriage Legalized
14.	International GNP Tax
15.	Marijuana Legalized
16.	Citizen Sampling Simulations
17.	"Sexicare"
18.	Time Travel by Deepfreezing
19.	Global 3-D Color TV
20.	Air Cushion Vehicles
21.	Manned Lunar Base
22.	Weather Modification
23.	Animal Donors
24.	National Data Bank
25.	Nationless Corporations
26.	Credit Card Economy
27.	Teaching Computers
28.	Legal Decisions by Computers
29.	Passing of Religion
30.	Intelligence Drugs
31.	Genetic Manipulation
32.	U. S. in Limited War
33.	Continued Urbanization
34.	Cloning of Humans
35.	All-out Nuclear War



*Data from demonstrations 12-16

TABLE III

RANK ORDER BY FREQUENCY WITH WHICH THE DEVELOPMENT WAS SELECTED FOR CONSIDERATION*

Development	Number of times Chosen for Investment
1. Pollution Control	31
2. Racial Barriers Eliminated	25
3. Complete Nuclear Disarmament	23
4. Abortion Legalized	21
5. All-out Nuclear War	19
6. Population Planning	18
7. Continued Urbanization	15
8. Genetic Manipulation	15
9. Citizen Sampling Simulations	13
10. Cloning of Humans	13
11. Group Marriage Legalized	13
12. International GNP Tax	13
13. Treaty Banning CBW R & D	12
14. World Aid Program	12
15. World University	12
16. Marijuana Legalized	11
17. Passing of Religion	11
18. U. S. in Limited War	11
19. Air Cushion Vehicles	10
20. Credit Card Economy	10
21. Legal Decisions by Computers	10
22. Manned Lunar Base	10
23. "Sexicare"	10
24. Intelligence Drugs	9
25. National Data Bank	9
26. Animal Donors	8
27. Ocean Farming	8
28. Synthetic Food	8
29. Global 3-D Color TV	7
30. Staggered Work Week	7
31. Weather Modification	7
32. Nationless Corporations	6
33. Teaching Computers	6
34. World Currency	4
35. Time Travel by Deepfreezing	3

* Data from demonstrations 12-16, a total of 41 people

TABLE IV

RANK ORDER BY FREQUENCY WITH WHICH BACKGROUND INFORMATION WAS REQUESTED*

Development		Number of times background information was requested
1.	Cloning of Humans	22
2.	"Sexicare"	21
3.	Citizen Sampling Simulations	17
4.	Pollution Control	15
5.	Racial Barriers Eliminated	15
6.	Treaty Banning CBW R & D	15
7.	Complete Nuclear Disarmament	14
8.	Group Marriage Legalized	14
9.	Passing of Religion	14
10.	Population Planning	14
11.	Abortion Legalized	13
12.	Animal Donors	13
13.	Genetic Manipulation	11
14.	All-out Nuclear War	10
15.	Air Cushion Vehicles	9
16.	Continued Urbanization	9
17.	International GNP Tax	9
18.	Ocean Farming	8
19.	World University	8
20.	Intelligence Drugs	7
21.	Legal Decisions by Computer	7
22.	National Data Bank	7
23.	Staggered Work Week	7
24.	Nationless Corporations	6
25.	U. S. in Limited War	6
26.	World Aid Program	6
27.	Marijuana Legalized	5
28.	Synthetic Food	5
29.	Credit Card Economy	4
30.	Manned Lunar Base	3
31.	Teaching Computers	3
32.	Time Travel by Deepfreezing	3
33.	Global 3-D Color TV	2
34.	World Currency	2
35.	Weather Modification	1

* Data from demonstrations 12-16

TABLE V

ANSWERS TO QUESTIONNAIRE AT
END OF EXPLORATION*

1. Is the outcome close to or far away from the future you had hoped to achieve?

a.	very close	2
b.	close	14
c.	slightly close	19
d.	slightly far	2
e.	far	1
f.	very far	1

2. If you had it to do all over again, would you change any of your investments?

a.	yes	25
b.	no	15

3. I found the information in the background paragraphs

a.	helpful	33
b.	not helpful	4
c.	wrong	2

4. I found the instructions on what to do next

a.	sufficient	34
b.	insufficient	2
c.	repetitious	1
d.	badly written	2

5. All in all I found the Delphi exploration to be

a.	loads of fun	10
b.	fun	25
c.	a bore	0
d.	a complete waste of time	1

6. Sex

a.	F	12
b.	M	24

* Data from demonstrations 12 to 16

TABLE V (Contd.)

7. Year in school

a.	freshman	2
b.	sophomore	2
c.	junior	0
d.	senior	4
e.	graduate student	20
f.	professor	15

TABLE VI

DEVELOPMENTS IN WHICH PEOPLE WOULD
HAVE CHANGED THEIR INVESTMENT*

Development	Number of times listed
1. Continued Urbanization	5
2. Pollution Control	4
3. U. S. in Limited War	4
4. Complete Nuclear Disarmament	3
5. Legal Decisions by Computers	3
6. Ocean Farming	3
7. Passing of Religion	3
8. Population Planning	3
9. Racial Barriers Eliminated	3
10. Treaty Banning CBW R & D	3
11. World Aid Program	3
12. Cloning of Humans	2
13. International GNP Tax	2
14. National Data Bank	2
15. Synthetic Food	2
16. World Currency	2
17. Abortion Legalized	1
18. All-out Nuclear War	1
19. Genetic Manipulation	1
20. Group Marriage Legalized	1
21. Intelligence Drugs	1
22. Nationless Corporations	1
23. "Sexicare"	1
24. Staggered Work Week	1
25. Teaching Computers	1
26. Weather Modification	1
27. Air Cushion Vehicles	0
28. Animal Donors	0
29. Citizen Sampling Simulations	0
30. Credit Card Economy	0
31. Global 3-D Color TV	0
32. Manned Lunar Base	0
33. Marijuana Legalized	0
34. Time Travel by Deepfreezing	0
35. World University	0

* Data from demonstrations 12-16

demonstrations were not randomly selected from the population at large. They were not even randomly selected from the university community. The disciplines represented are suggested by the groups listed in Table I. The data in Table V, questions 6 and 7, shows the distribution of people according to sex and year in school. An open-ended question on political viewpoint stimulated frequently extended critiques of American society. My own interpretation of their answers indicates that there were two radical liberals, 10 liberals, and 2 people between middle and right wing.

Furthermore, the people were not randomly selected in terms of their interest in the exploration. With the exception of a few students in political science classes, all of the explorers to date have asked to work through the exploration or have responded to the encouragement of a friend to do so. The most frequent pattern is for an interested faculty member to bring along either a group of faculty members or a class of graduate students. We have not yet systematically sought representative samples since we are still primarily concerned with the development of a more interesting program from the viewpoints of both education and research. Consequently this data is presented only as a very preliminary indication of the kinds of responses that can be obtained when using a computer-based communications medium to discuss an area of public policy. The responses should not be interpreted as representative of how the American people or even university people would rate the desirability of the developments listed. The data is useful in indicating how many possible future developments can be considered by an educated person in a given period of time.

Measures of performance

Despite extensive instructions at the beginning of the exploration, a few people have great difficulty figuring out what they are supposed to do. This is shown by the fact that in Figure 3 several people were able to complete only a very few cycles.

The time allotted for the exploration was in most cases one hour. The demonstration on 2/20/71 extended to about an hour and twenty minutes. For the five demonstrations of the 40 information unit game the mean number of cycles completed was 10.3. For the four demonstrations in which only one hour was available, a mean of 8.9 cycles were completed with the mode being 8 and the median 10.

The number of people requesting a particular number of background paragraphs is shown in Figure 4. The mean number of background paragraphs requested was 8.8. The mode was 6 and the median 11.5.

The number of people having a particular number of random events occur in their exploration is given in Figure 5. The mean number of events in an exploration was 1.7. The mode was 1 and the median 2.5.

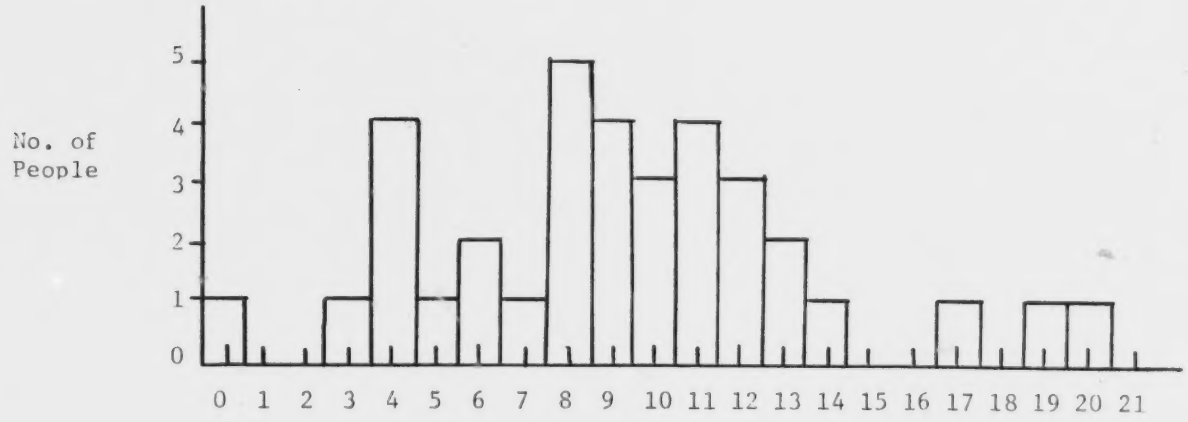
Figure 6 shows the number of people who made a certain number of comments. The mean number of comments was 1.6. The mode was 1 and the median 2. Everyone was explicitly asked for comments, suggestions, and criticisms as one part of the questionnaire at the end of the exploration. Consequently there were very few people who made no comments, or a response such as "none" in answer to that question. Those people who made only one comment did so in reply to the specific request and did not interrupt the exploration in order to go into the "comment mode".

Comments by explorers

The comments made by the participants during the demonstrations reflected a variety of criticisms, suggestions, questions, and general reactions. These can be grouped in the following categories.

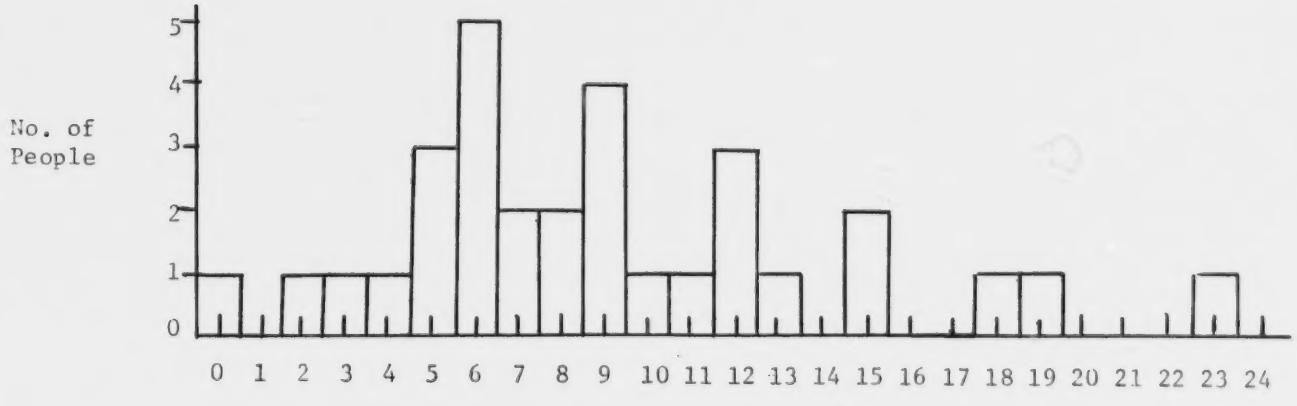
1. Technical errors. Debugging is an activity familiar to all computer programmers. Debugging a program on a teaching computer involves calling in some friends who either have a knack for making things go wrong or who find a malicious glee in outwitting a computer.

FIGURE 3
TOTAL NUMBER OF CYCLES COMPLETED*



* Data from demonstrations 12, 14, 15, 16

FIGURE 4
TOTAL NUMBER OF BACKGROUND PARAGRAPHS REQUESTED*



* Data from demonstrations 12-16

STUDENT TERMINAL

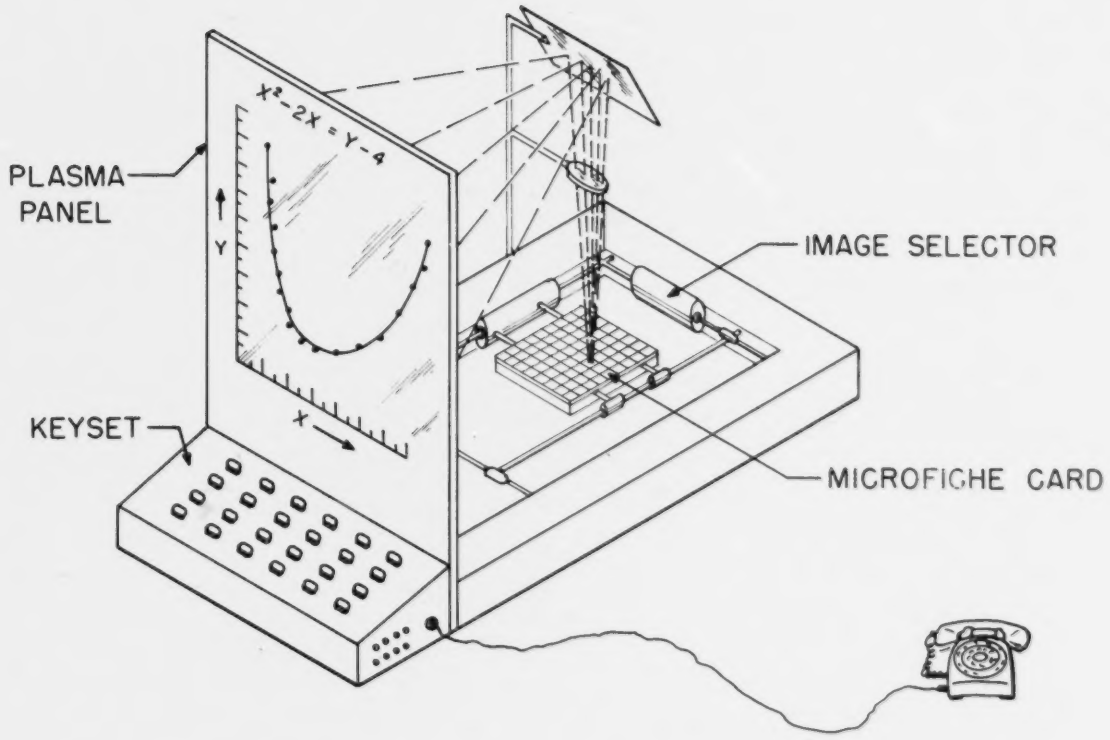
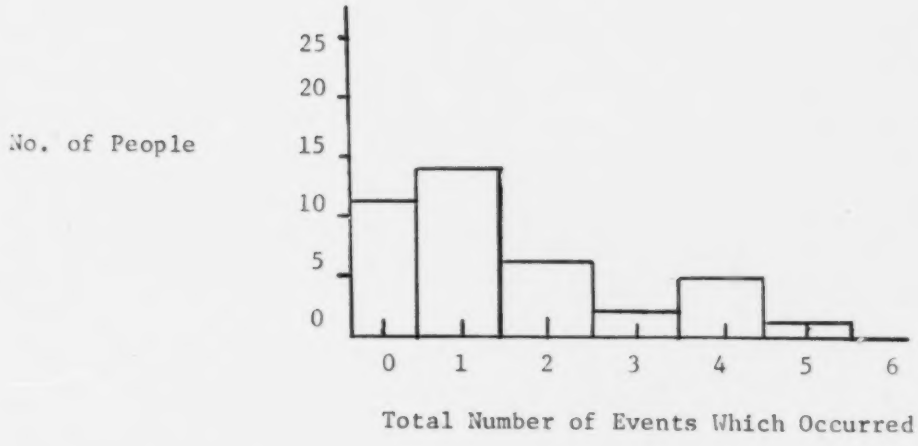
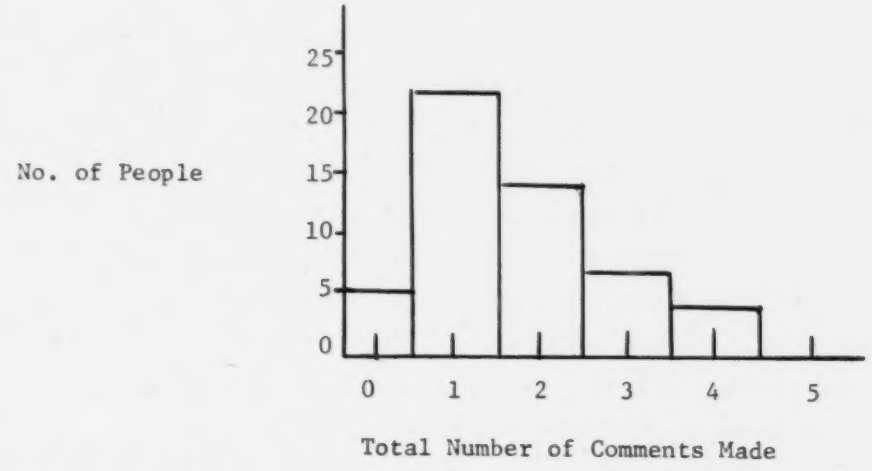


FIGURE 5
TOTAL NUMBER OF EVENTS WHICH OCCURRED*



* Data from demonstrations 12-16

FIGURE 6
TOTAL NUMBER OF COMMENTS MADE*



* Data from demonstrations 11-16

Examples of technical errors would be that the computer does not accept a negative number when it should, or it accepts a letter when it should accept only numbers. A few participants were quick to point out such errors: "Ha! You made a mistake."

2. Instructions. Nearly every exploration produces suggestions for clarifying the instructions. For example, "I did not understand how to invest and make a meaningful contribution toward my goal." "It would be helpful if we were given a reminder to enter our choices and outcomes on the data sheet." "Need more explanation of what you mean by investment."

3. The purpose of the exploration. In a game in which no score is kept, where the object is to make the desirable probable and the undesirable improbable, expressions of confusion are to be expected. "The final results of the game or the goals were not clear to me." Some people seem to have difficulty conceptualizing complex systems. "I had difficulty realizing the issues. Consequently, I'm not sure I was making intelligent decisions." On the other hand, some people experience "an awakening of the sense of the future of man."

4. Important items not included. Some of the most thoughtful and helpful comments deal with what is not included in the exploration. "I did not think that there were enough policy factors involved in the issues contained here. For example I would have liked to see the question of manipulation of the individual considered more explicitly--in other words questions about attitudinal changes." "Complete disarmament rather than nuclear disarmament should be one of the futures included."

5. The original probabilities. Explorers sometimes question the actual estimates. "All out nuclear war is not possible." And sometimes they question who made the estimates. "I am curious as to how the original probabilities for the given issues were determined."

6. Background paragraphs. The brief background information was challenged usually for not giving sufficient attention to consequences, regulation, or alternative solutions. "Nothing was

mentioned about the effects of pressure on the surface the air cushion vehicle is going to be passing over. Until the ecological effects of such an apparatus over a natural surface are determined, I would seriously question such an apparatus." "In such items as cloning of humans, crucial matters would be the regulations that go along with the process. It is difficult to decide if it is good or bad without at the same time fixing some of the regulations." "Legislation or executive action is not needed to stabilize population growth rate--education is the answer to this problem."

7. Secondary effects. Questions about secondary effects ranged from who determined them and the logic used, to amazement that there were so many. For example, "How does a 100% investment in world aid program reduce probabilities of ocean farming and synthetic food?" "I am unclear as to how the associations were decided upon after I had made my investment or an event had happened. Some of them did not make sense to me. Like some of the considerations were left out." "I do not see what happened at this point which caused the probability of limited war to increase." "I would have been interested in how various choices affected other events specifically, e.g. a little more about why one probability caused a particular change in another variable." "Frightening how one decision influences so many others you never took into consideration when making your initial decision. On some do not see off hand how the influence came about."

8. What makes the exploration enjoyable. "I like when you add the event to make it more exciting." "I was angry at being told what to do in such a demanding way by a machine. My hands felt slapped each time I made a mistake." "I would have liked to have finished in order to see the full picture of the world. Occasionally became bored, however, perhaps due to each step being handled in the exact same manner as the previous."

9. The dangers or opportunities implied by this technology. Only a very few people remarked on the potential of this kind of equipment and this kind of program for radically altering the process of citizen participation in planning. The people who do comment on

this possibility have usually been students who were told in advance what this work might lead to. More than we would like, people have concentrated on the information in the program rather than thought about the possibilities of this kind of information exchange. "Concerning this computer, I hope we never go into teaching children by this means even though I can see where it may be more efficient. Learning how to deal with people seems much more important to me." "The greatest difficulty here is that as well explained as the process is, it is still very confusing. I am not sure you could ever get the general public to use them as the general public strikes me as being very lazy and therefore would not consider this worth the effort." "I think the idea is very interesting and has many possible applications especially in finding out what the common level of awareness is and where work is needed to bring what area up." "A great start at showing the inter-relationship of various particular choices."

FURTHER NOTES ON SOCIAL IMPLICATIONS

Not all of the analysis which can be performed on the data from these demonstrations has yet been carried out. But perhaps the preceding discussion is adequate evidence that the earlier and following speculations and philosophical musings are based on experiences with operational though still elementary prototypes.**

** An earlier consideration of possible social, political, and psychological implications of citizen participation in planning using computer-based communications media is contained in reference 4.

The practicality of public discussions

The data presented here is useful in estimating the feasibility of widespread use of "citizen sampling simulations" to involve the public in the planning process. It is to be expected that some people

will be intimidated by the thought of using a computer and will be overwhelmed by this advanced communications technology. As was mentioned earlier, there is some evidence that a few people do have great difficulty with the program or at least proceed very slowly. Nevertheless, learning how to use a new technology and also exploring a list of 35 unusual social and technological developments is a demanding task for a one hour period. The success of these people in performing that task leads us to believe that community issues can be discussed by the public with this kind of technology, particularly as people gain practice in using it.[10]

The power of suggestion

The method of describing the future using information units seems to have been successful. Most people find the experience educational, and the basic structure of the program--the way the future is described--has not been criticized by most people who play the game. However, a few perceptive observers have expressed skepticism about the exploration, and rightly so. Simply listing a set of possible developments structures the thinking of explorers and thereby severely limits the range of responses. This is confirmed by the fact that people rarely suggest new developments or criticize the list given.

Those observers who are equally concerned but less theoretically inclined question the assumptions about the world which led to the selection of that particular set of forty information units. Furthermore there is a danger that some individuals may assume the changes in probabilities are "real" or indicate something more than merely the aggregated judgment of a group of individuals.

In future explorations we intend to make even more explicit the fact that the original probabilities and the changes in probabilities of other developments which we call "secondary effects" merely reflect the judgment of the programmer and the people he has consulted and

that the consequences indicated are not determined by a computer model based upon verified theories of the operation of social systems.

A program now being developed on a specific problem area, the Future of the University, uses probability, desirability, and importance ratings and both occurrence and non-occurrence matrices for three separate groups--students, faculty members, and administrators. In this program the computer is serving as a communications medium between the programmer and the people at the terminals. In the Future of the University program the fact that the computer is simply operating as a mediator among groups of people with different patterns of concern and perceptions of the world is made much more explicit.

Who is communicating with whom?

Even though the responses of each individual are not automatically seen by the other participants and the program itself may be changed only at intervals involving weeks or months, communication can still be taking place. In order to clarify the differences among Delphi-like computer programs it is useful to keep in mind whether individuals or groups are communicating with each other, the number of times a single individual will sit down at a computer terminal in order to work on one particular problem, and how much monitoring or editing of responses is done by the programming staff.

1. In Turoff's Delphi Conferencing, as I understand it, the responses of each individual are seen by all the other participants in the exercise. Items are added or dropped on the basis of a vote taken among participants. No monitoring or editing of the exercise is done by anyone except the participants themselves. Each time a person responds to a question or types a statement his response is not only recorded for viewing by the programmer but actually alters the program which each participant will view thereafter. Each person works on the given problem for a few minutes every day for several days.

TABLE VII

GROUP COMMUNICATION TECHNIQUES

	Delphi Conference	Citizen Sampling Simulation	Computer-based Mediator
Participants	individuals	planning group and the public	interest groups 2 or more
Length of Interaction	minutes	1 to 2 hours	1 to 2 hours
Number of Interactions	several, usually 1 per day	usually only one	usually only one
Normal Mode	usually group control and no monitor	at present completely monitored	at present only list of items not modifiable

2. The idea behind the Delphi Exploration, which can be thought of as a prototype "citizen sampling simulation," was to have communication take place not among individuals but rather between the planning group and the public. The responses of the explorers are recorded and viewed by the monitoring group but do not automatically change the program itself. This pattern is similar to the normal process of instruction where communication takes place primarily between the teacher and the students. Each explorer works on a particular problem probably only once, at a sitting lasting from one to two hours. If the issue is a recurring one, the program is changed only every few weeks or months when the programming staff has an opportunity to reconsider the issue and to change the program on the basis of the responses obtained since the last modification of the program. The purpose of this kind of exercise is not to generate a forecast or a set of policy alternatives but rather to reduce the amount of time spent by planners in presenting background information to interested citizens and to generate data from the public on the desirability of particular alternatives, the completeness of the set of alternatives considered, and the way in which "the problem" is defined.

3. For a "computer-based mediator," such as the program on the Future of the University, communication takes place neither among individuals nor between planners and the public with the planners also acting as monitors, but rather between conflicting interest groups with either no monitor or a neutral party acting as monitor/arbitrator. The responses of individuals are not seen by the other participants except in the mean responses of a group. The position of each group is not arrived at by negotiation or compromise within the group but rather results from averaging the views of individuals in the group. In the present program the responses of an individual alter his group's estimates of probabilities, desirabilities, and causal relationships, but the list of information units can only be changed by the programmer.

The practice in Delphi Conferencing of allowing the participants themselves to add and drop information units is a very important capability which can be incorporated into both citizen sampling simulations and computer-based mediators.

Exchanging views vs. simulating complex systems

There is a tendency to confuse this project with the presently growing number of attempts to model complex social systems. If that were our purpose, we would be greatly hampered by the technology we are using. The PLATO system was designed to operate a large number of computer terminals simultaneously with each terminal being allocated a small amount of computer memory space. Our efforts are sufficiently similar to the modeling of complex systems that we have attempted to keep up with developments in that area in hopes that the form of the models would be applicable to our programs.

However, given the limitations of our equipment for doing that kind of work and given its uniqueness for doing the task for which it was designed, we believe that it would be most productive to spend our time developing the computer as a communications medium between people and as a device for helping less skilled people to articulate their mental models of how the world works. Since computer models of social systems inevitably embody the assumptions of the programmer about what the important variables are, the ability of less technically skilled groups to express their assumptions about important variables could be helpful in trying to achieve a balance of political influence.

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